TAYLOR

Relation Between the Succulency and Composition of Peas

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RELATION BETWEEN THE SUCCULENCY AND COMPOSITION OF PEAS

BY

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Everett Harvey Taylor

ENTITLED Relation Between the Succulency and Composition of Peas.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science in Chemistry.

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RELATION BETWEEN THE SUCCULENCY AND COMPOSITION OF PEAS.

This investigation was undertaken with a view to ascertaining whether there are any easily obtainable constants in green peas which may be used as criteria for the time required in blanching and to compare the methods of obtaining these constants. The sugar contents, moisture content and specific gravity were particularly considered. In addition to these purposes observations were made when the blanching procedure was modified in different ways.

The blanch consists of a preliminary washing of the peas in hot water and is performed in order to remove the excess mucilaginous material and coloring matter which would otherwise cloud the liquor, and also to force water into the peas, thereby rendering them tender. At the present time the Plummer blancher is used almost exclusively in the pea canning industry. This consists of a large rectangular pan, filled to a depth of about six inches with water which is kept boiling with live steam. A large wire cylinder, which dips into the water, revolves at such a speed and bevel as to cause the peas which are placed into it at one end to be discharged at the other end in a specified length of time. The entire machine is covered in order to prevent undue loss of heat. In some of the experiments described below the blanch was carried out in an open beaker. In this case the peas were immersed in boiling water during the entire period.

After a series of experiments on peas of different ages, Diggs[1] came to the conclusion that young peas contain a higher percentage of sugar than those which are nearly mature. Before this factor can be used for comparing the hardness of two samples of peas of approxi-

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1- J. Ind & Eng. Chem. 6, 310 (1914).

mately the same age, however, it is necessary to bear in mind that the transformation of sugar is affected by many conditions.

The sugar was determined by Defren's method and also by direct and invert polarization. As the result of a number of preliminary examinations the sugar present was found to be entirely sucrose. Thus in one sample the direct polarization gave 3.82 percent sucrose, while double polarization gave 3.62 percent. In another sample the mean of two determinations by Defren's method gave 3.43 percent, while direct polarization gave 3.42 percent. These results agree with the researches of Schwartz and Riechen[1] who analyzed several cans which they had carefully controlled. In particular they made certain that no sugar nor other sweetening material was added to the brine. The liquor and peas were separately analyzed for sugar by extraction with water, clarification with lead salts and sodium phosphate, precipitation of dextrin with alcohol, and finally double polarization. In this way they obtained values for sucrose which are somewhat higher than those recorded in the following tables, their values being in the neighborhood of twenty-seven percent of the dry weight. No doubt this difference may be ascribed in part to the fact that they used No. 3 peas, while those used by the writer were No. 5, which are the largest peas used for canning purposes. In view of the fact that sucrose only was found to be present, the direct polariscopic reading only was taken in most of the determinations recorded in the tables which follow.

The density was determined by putting twenty green peas in a cylinder and adding water or a strong salt solution till half the peas floated. The hydrometer reading was taken at 25.5 degrees ex-

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1- Zts. Nahr. u. Genuss. 7, 550.

cept on Series 3, when it was taken at 17 degrees. Since the hydrometer was adapted for 16 degrees the recorded readings represent relative densities only. The data are incomplete owing to the fact that the cylinder was broken shortly before the close of the season and could not be replaced at the plant.

The moisture of the green peas was determined by means of a single-walled Brown-Duvel Flask. Owing to difficulties in regulating the gasoline burner some condensation took place in the neck and stem of the flask, but this would probably not introduce much additional error since globules of water always collect in the condenser when this apparatus is used.

In each series ten cans were prepared, comprising duplicates of five cans, as follows: (1) A factory can, blanched in the Plummer blancher for eighteen minutes; (2) blanched in an open beaker in tap water for thirty-six minutes; (3) blanched in an open beaker in distilled water for eighteen minutes; (4) blanched in an open beaker in tap water for nine minutes; (5) blanched in an open beaker in tap water for thirty-six minutes. One of the duplicate sets of cans was opened just after the close of the canning season; the other was opened during the following winter. On each occasion the peas were examined for percentage broken, moisture content, crude fibre content, and hardness.

Fifty peas taken at random were ordinarily used in estimating the number broken. In cases where this gave a value of less than 4% for the number broken, one hundred peas were used.

The moisture in the canned peas was determined in two ways. In the case of the cans which were opened during the summer, as well as the first can of each series opened during the winter, the moisture

was determined by drying in an oven at 110 degrees. In all other cases the moisture was determined by allowing the peas to drain in a Buchner funnel covered with a glass plate for twenty minutes, and then weighing the peas. Since exactly two hundred grams of peas had been placed in each can, and since the moisture content of the green peas was known, the percentage of moisture in the canned peas could be directly calculated.

The crude fibre was determined by the official method of the Association of Official Agricultural Chemists[1] with the modifications that instead of two hundred cubic centimeters of reagent, one-half that quantity was used, with a correspondingly smaller quantity of material.

The hardness was tested by reading the number of millimeters it was necessary to pull a brass spring in order to burst the pea. An average of about thirty readings was taken. Different springs were used in the summer and in the winter; consequently the two sets of readings cannot be compared. Only the two springs were used.

In the tables which follow the large number of vacant spaces is to be ascribed to a variety of causes; lack of distilled water, l lack of time for blanching thirty-six minutes, destruction of peas by mice, and so forth. All cans of Series 15 were lost in the warehouse. In the first three columns of each table are given the results of the investigations of the green peas; in the last four columns are given the results of the investigations of the canned peas. Table I, records the investigations of the cans which were opened during the summer: Table 2, records the investigations of the cans which were opened during the winter.

1- U. S. Dept. of Agriculture, Bureau of Chemistry Bul. 107 (rev) P. 56.

TABLE 1.

Series and can	Hydrometer reading	Moisture % (green) (peas)	Sucrose %	Moisture %	Broken %	Crude fibre	Spring test mm.
1 - 1	1.072	72.4		77.2		9.70	
1 - 2				75.1		6.89	
1 - 3				75.0		7.88	
1 - 4				76.9			
2 - 1	1.098	68.0		72.7		8.20	88.6
2 - 2				72.3			89.4
2 - 3				74.0		8.91	41.7
2 - 4				74.0			93.8
2 - 5				74.0			86.3
3 - 1	1.051	75.5	1.50	79.2			86.9
3 - 2				80.0		6.89	64.6
3 - 3				77.9			83.6
3 - 4				78.7			87.2
3 - 5				79.5			75.8
4 - 1		76.0	1.63	77.8	25.		75.3
4 - 2				77.8	11.		97.2
4 - 3				76.4	12.0		85.0
4 - 4				79.5	13.0		84.0
4 - 5				80.0	16.0		102.0
5 - 1	1.060	76.0	1.55	78.0	54.0		82.4
5 - 2				79.4	47.0		113.2
5 - 3				78.8	49.0		98.0
5 - 4				77.6	51.0		114.0
5 - 5				78.5	40.0		113.6
6 - 1	1.075	76.0	3.72	86.9	60.0	9.49	69.5
6 - 2				81.4	12.0		92.5

Series and can	Hydrometer reading	Moisture % (green) (peas)	Sucrose %	Moisture %	Broken %	Crude fibre %	Spring test mm.
6 - 3				82.2	22.0	11.68	82.0
6 - 4				75.0	12.0		92.0
6 - 5				94.2	7.0	11.04	101.0
7 - 1	1.070	77.0	3.42	82.6	50.0		72.7
7 - 2				85.0	14.5		70.8
7 - 3				84.5	15.5		61.3
7 - 4				84.0	16.0		94.0
7 - 5				85.5	15.0		84.5
8 - 1	1.072	76.8	3.55	76.4	46.0		74.7
8 - 2				78.5	9.1		110.5
8 - 3				77.2	7.4		116.4
8 - 4				79.5	5.5		149.5
8 - 5				88.6	15.0		118.0
9 - 1	1.070	77.4	3.42	78.8	60.5		74.5
9 - 2				80.4	7.5		106.0
9 - 4				82.3	5.5		121.0
9 - 5				82.3	7.5		102.0
10 - 1	1.081	78.6	2.54	79.7	36.0		104.2
10 - 2				73.7	5.5		114.5
10 - 4				83.5	9.0		143.0
10 - 5				82.0	7.5		103.8
11 - 1	1.077	74.0	2.83				
11 - 2				81.4	4.0		92.1
11 - 4				79.8	7.5		118.8
11 - 5				78.9	4.0		130.6
12 - 1	1.071	78.5	3.67	80.8	29.5		81.4

Series and can	Hydrometer reading	Moisture (green) (peas)	% Sucrose %	Moisture %	Broken %	Crude fibre	Spring test mm.
12 - 2				83.0	31.5		106.4
12 - 4				81.4	25.0		139.0
12 - 5				80.5	17.0		120.0
13 - 1	1.068	74.5	4.94	78.3	48.5		91.0
13 - 2				82.3	15.3		111.6
13 - 4				80.4	9.0		144.3
13 - 5				81.7	7.9		128.7
14 - 1	1.075	77.5	4.67	79.9	5.4	12.75	62.8
14 - 2				84.0	2.8	13.02	99.8
14 - 4				83.0	5.6	14.05	105.8
14 - 5				83.6	13.8	13.26	117.1
16 - 1		75.0	5.17	76.4	19.4		97.5
16 - 2				79.6	28.6	13.57	146.5
16 - 4							
16 - 5				79.6	24.2	11.10	122.5
17 - 1		77.5	3.79		36.7		115.0
17 - 2					45.6		166.5
17 - 4				78.9	59.0	8.34	188.4
18 - 1		73.0	2.70		66.0		91.3
18 - 2				78.3	3.8	11.82	156.3
18 - 4				77.4	15.2	15.42	180.2
19 - 1		73.6	4.70	79.4	52.5	10.58	102.4
19 - 2				80.7	6.9	11.41	125.3
19 - 4				78.6	6.9		152.8
20 - 1		73.5	4.11	81.7	57.0		75.0
20 - 2				81.3	39.7	15.68	128.1

Series and can	Hydrometer reading	Moisture (green) (peas) %	Sucrose %	Moisture %	Broken %	Crude fibre %	Spring test mm.
20 - 4				81.9	41.8	13.16	143.1
21 - 1		74.5	4.64	81.2	51.0	11.67	80.3
21 - 2				83.2	3.8	11.25	121.0
21 - 4				77.0	15.2		127.1
22 - 1		75.0	4.93	77.8	26.0	10.33	121.5
22 - 2				80.7	3.8	11.72	159.0
22 - 4				80.4	15.3	12.0	151.5

TABLE 2.

Series and can	Hydrometer reading	Moisture (green) (peas)	% Sucrose %	Moisture %	Broken %	Crude fibre %	Spring test mm.
1 - 1	1.072	72.4		76.4		10.06	
1 - 2				74.0		7.95	
1 - 3				74.3		10.20	
1 - 4				73.8		9.83	
2 - 1	1.098	68.0		72.7	45.0	7.26	54.6
2 - 2				70.2	22.5	9.42	50.0
2 - 3				71.8	30.0		69.0
2 - 4				69.0	23.0	8.42	41.2
2 - 5				69.3	13.0	9.67	55.4
3 - 1	1.051	75.5	1.50	78.9	18.0		30.0
3 - 2							
3 - 3							
3 - 4				75.9	3.0	12.73	46.4
3 - 5				75.3	10.0	13.66	39.0
4 - 1		76.0	1.63	77.1	27.5	7.67	29.0
4 - 2				75.6	3.0	11.09	48.2
4 - 3				76.0	10.0	11.92	26.4
4 - 4				75.7	6.6	11.93	36.8
4 - 5				75.9	20.0	12.98	41.2
5 - 1	1.060	76.0	1.55	80.0	23.1	11.14	37.6
5 - 4				75.8	42.0	12.38	56.6
5 - 5				75.7	65.0	12.56	67.1
6 - 1	1.075	76.0	3.72				
6 - 2				75.2	2.0	11.52	31.0
6 - 4				74.8	4.0	7.79	33.0

Series and can	Hydrometer reading	Moisture % (green) (peas)	Sucrose %	Moisture %	Broken %	Crude fibre	Spring test mm.
7 - 1	1.070	77.0	3.42	81.8	10.0		14.0
7 - 2				76.3	3.0	14.75	30.9
7 - 4				76.2	8.0	13.12	31.4
7 - 5				76.5	16.0	12.22	35.0
8 - 1	1.072	76.8	3.55	76.7	19.0	10.60	51.2
8 - 2				77.5	2.0	11.35	81.0
8 - 4				77.2	8.0	13.70	60.4
8 - 5				77.6	2.0	12.23	81.3
9 - 1	1.070	77.4	3.42	80.4	23.0		41.0
9 - 2				80.4	6.0		84.5
9 - 4				77.4	6.0		43.6
9 - 5				77.2	2.0	13.64	67.0
10 - 1	1.081	76.8	2.54	77.4	7.0	10.90	60.4
10 - 2				77.3	3.0		87.6
10 - 4				76.8	2.0	12.33	92.4
10 - 5				76.9	12.0		80.6
11 - 1	1.077	74.0	2.83	78.8	16.0	9.88	50.0
11 - 2				73.6	10.0		76.0
11 - 4				73.0	4.0		67.7
11 - 5				73.8	4.0		65.7
12 - 1	1.071	78.5	3.67	83.1	30.0	11.90	22.4
12 - 2				78.9	20.0	11.68	62.8
12 - 4				78.7	26.0		54.4
12 - 5				78.8	12.0		46.5
13 - 1	1.068	74.5	4.94	79.4	8.0	10.58	52.0
13 - 2				74.0	4.0		72.4

Series and can	Hydrometer reading	Moisture (green) (peas) %	Sucrose %	Moisture %	Broken %	Crude fibre %	Spring test mm.
13 - 4				74.0	8.0	13.13	75.4
13 - 5				74.4	6.0	12.71	92.2
14 - 1	1.075	77.5	4.67	80.3	8.0	10.74	35.0
14 - 2				77.5	6.0	12.46	65.5
14 - 4				77.2	2.0	12.20	59.5
14 - 5				77.5	4.0	13.75	33.3
16 - 1		75.0	5.17				
16 - 4				75.6	48.0		85.0
17 - 1		77.5	3.79	76.6	36.0	11.73	78.4
17 - 2				79.3	30.0	11.18	139.5
17 - 4				79.5	46.0		113.5
18 - 1		73.0	2.70		50.0		91.8
18 - 2				75.4	14.0	12.82	122.5
18 - 4				74.9	8.0	12.84	79.5
19 - 1		73.6	4.70				
19 - 2				74.2	8.0	11.54	77.5
20 - 1		73.5	4.11	76.8	22.0	12.00	58.0
20 - 2				78.8	36.0	11.10	71.0
20 - 4				74.0	26.0		87.0
21 - 1		74.5	4.64	81.1	22.0	12.26	68.0
21 - 2				75.0	6.0	11.97	71.5
22 - 1		75.0	4.93	77.3	8.0	10.30	68.0
22 - 2				75.4	2.0	12.82	98.0

In the examination of the foregoing data for possible correlation of characters the different series or cans were arranged in order of magnitude with respect to some particular property. Thus, the arrangement of series with respect to sugar content would be: 3, 5, 4, 10, 18, 11, etc. The arrangement of cans numbered four, opened during the summer, with respect to the spring test for hardness would be: 4, 3, 6, 2, 7, 14, 5, 11, etc. All the data were rearranged in this manner and then carefully examined.

No correlation was detected between the sugar content and the hardness of the pea and the variation of the former is to be ascribed to the conditions which affect its transformation in the normal metabolism of the plant. These conditions would not ordinarily affect the factors determining the hardness of the pea, especially when marrowfats only are considered, as in this case.

The moisture content was found to be so nearly uniform as to hold out little promise. It was, moreover, found to be extremely difficult to determine in green peas of approximately the same age, because in dry, windy weather a very few minutes caused a marked change in composition. Under such conditions a slight delay at one of the viners would in my opinion, cause a greater variation in the moisture content than ordinarily occurs in fresh peas of approximately the same age.

The record of density is too incomplete to be of value. Considering the great effect of small temperature changes on the density of solution, my experience leads me to the conslusion that in order to obtain accurate values for the density of green peas the cylinders must be placed in a thermostat, and not simply held in the hands as in the customary method for the testing of brines. With this modification I think the method previously described will be found to give

accurate results.

Of methods for examination of the canned peas it may be said that the spring test agrees in the main with the crude fibre content. This is most pronounced where the data are most complete, as in Series 4, 8, 13, 14, 22. The count of broken peas and the moisture content seem to be of little value in the examination. With respect to the former it is to be remembered that the peas which were placed in the factory can were not so carefully picked over as the others. In cases where the moisture was determined by draining in a Buchner funnel, as before described, the results seem to show greater uniformity than where the determination was made in an oven.

Of the different forms of blanching it may be said that the Plummer blancher produced softer peas, as shown by the spring test and crude fibre analysis. It is possible, however, that this result was brought about by the greater mechanical abrasion which the peas were forced to undergo. The fact that they were in an atmosphere of steam for a part of the time may also have had an effect. The result is certainly suggestive.

In six cans out of nine the spring test shows that the peas blanched in distilled water are softer than those blanched in tap water. The result is not altogether convincing. In fourteen cans out of eighteen the peas which were blanched for only half the regular length of time were found to be hardest of all. The effect of blanching for double the regular length of time seemed to be less pronounced.

SUMMARY.

1. The sugar content of peas of approximately the same age is not correlated with the hardness.

2. The method of determining the specific gravity of green peas above described would undoubtedly prove rapid and accurate if the cylinder were placed in a thermostat.

3. Practical difficulties eliminate the consideration of moisture content as a measure of hardness of green peas.

4. The spring test above described appears to be the most reliable and rapid method of estimating the hardness of canned peas.

5. When the quantity of green peas placed in the cans is known the moisture content of canned peas may be rapidly and accurately determined by draining thru a Buchner funnel.

6. Peas blanched in the Plummer blancher are softer than those blanched in boiling water in an open heater for the same length of time.

7. The effects of underblanching are very striking, while the effect of overblanching is scarcely apparent, even when the length of time is doubled.